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BUREAU OF MINES
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INFORMATION CIRCULAR

PRECAUTIONS TO BE TAKEN WHEN APPROACHING OLD MINE WORKINGS

BY

D. HARRINGTON AND R. G. WARNCKE

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UNITED STATES DEPARTMENT OF THE INTERIOR - BUREAU OF MINES

PRECAUTIONS TO BE TAKEN WHEN APPROACHING OLD MINE WORKINGS[1]/

By D. Harrington[2]/ and R. G. Warncke[3]/

This circular does not propose or suggest any new or original safety practices for underground coal or metal mines, but it does call attention to the lack of consideration or utter disregard of an old and presumably widely known safety rule - the necessity for precaution when approaching old or abandoned workings of a mine. That the hazard of abandoned workings has long been recognized by the various mining States is evidenced by their enactment of safety orders and laws, which more or less adequately set forth rules and regulations to be followed when mine workings are driven in supposedly dangerous proximity to an abandoned mine or an abandoned or sealed section of a mine. A summary of the various State laws and regulations is to be found at the end of this paper.

Although these State laws are not uniform as to some of their requirements, such as the length of drill holes, the distance from old workings that drilling should start, the number of holes to be drilled, the direction in which they should be driven, their size or diameter, the objective or the fundamental purpose is the same - to protect the life of the worker and to prevent loss of the mine or parts of it. The distance from old workings at which drilling should start varies from 50 to 100 feet when the distances are known with exactitude, but in some States these distances are doubled if the separating distance is not definitely known. Some States do not stipulate a definite distance at which drilling should start, but where there is question as to the accuracy of the distance as scaled on a map or as calculated, it is advisable to start the precautionary drill holes approximately 200 feet from the place where the abandoned place is supposed to be. The drill holes vary in length from 9 or 10 to 20 or 25 feet ahead of the advancing face, and some States require lateral or angle holes to be

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drilled every 6 to 9 feet, their depth varying in the different States. A few States limit the maximum width of the working place approaching the old workings; this differs greatly, but one of the metal-mining States allow a maximum of 6 feet; the width in other States is about 8 feet. The Tentative Coal Mine Inspection Standards of the Bureau of Mines suggest that drilling of pilot holes start about 200 feet from the suspected workings and that the holes be kept at least 20 feet ahead of the face, with lateral holes on a 45° angle drilled ahead in each rib for a depth of 25 feet every 8 feet. In spite of all these laws for the protection of the workers and the knowledge mine officials should have of these hazards, many accidents are reported from sudden inrushes of water, outbursts of explosive gases, or the filling of active workings with air deficient in oxygen or high in carbon dioxide or both high in CO_2 and deficient in oxygen.

Many very serious accidents result from breaking into old workings, which should have been known to be close by; some of the break-throughs are into unsuspected hazards of water or mud or gas. The laws and rules or regulations designed to cover instances of this kind usually apply to suspected abandoned, sealed, or other types of old workings. The connecting of active workings from one section to another working section of a mine is seldom considered hazardous, and ordinarily little if any consideration is given when such connections are made or are about to be made. The hazard of this lack of consideration in making ordinary break-throughs is well illustrated in some of the following examples. Far too frequently, little or no thought is given to the effect the break-through will have on ventilation of the mine or the possibility of short-circuiting the air current in one or more sections of the mine. The break-through is overlooked in the resulting accident, whether large or small, until the accident is analyzed and the break-through is found to be the primary cause of the accident. This can be caused by any type of connection; between different sections, between entries or even between rooms. This is especially true in a gassy mine where a slight interruption of the air will allow explosive mixtures of gas to accumulate rapidly and the hazard is much enhanced if there are differences of elevation between the two places such as frequently occurs in pitching coal beds. Fortunately, these types of cases are rare, nevertheless, consideration should be given to all types of break-throughs, and especially is this true in the rapid development of coal mines using mechanized methods of mining, drilling, loading, and transporting or hauling coal.

When old workings in metal mines are broken into, the danger is likely to be from water or air deficient in oxygen, whereas in coal mines there is the additional possibility of encountering methane, which is

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eleased into the active workings; the explosive-gas hazard applies to etal-mine workings, also, under some conditions. In coal mines (more nfrequently in non-coal mines), the sudden release of methane may re- ult in a mine explosion; however, the break-through is seldom held re- sponsible for the disaster, as usually the immediate ignition agency (such s nonpermissible electrical machinery, trolley locomotive, blasting with onpermissible explosives, smoking, or some other source of ignition) is aid to be the cause, which, in a sense, is true; upon further study, however he real cause of the explosion is found to be the newly made opening, hrough which the gas escaped.

Many mine explosions are caused by shots breaking through into nother working place and igniting the dust or gas and dust in suspen- ion from previous shots. Regardless of the poor safety of blasting ractices or the use of nonpermissible explosives, at least some of these xplosions have been caused by lack of knowing the close proximity of the orking places; possibly carelessness was responsible, or both careless- ess and lack of knowledge as to proximity. These explosions probably ould not have occurred had the distance separating the working places een known, which indicates poor supervision by mine officials.

The accidents discussed in this paper can be classified as those at occurred when it was known that other workings were being ap- roached or were supposedly known to be close, and those that broke nto workings not known or suspected to be close. Although the causes nd circumstances leading to such accidents may differ widely, methods f prevention are similar. One of the leading causes for both these classes f accidents is poor engineering or surveying and the lack of accurate maps. lany mines are worked without the use of engineers or surveyors or the enefit of a map, or, if a map is made, it is made only to cover State re- uirements. This is true especially of smaller mines, both coal and non- oal. The opening of many old or abandoned mines owing to the need for inerals for the war has greatly amplified this hazard. In changing oper- ting companies in many of these old mining properties the mine maps ere lost, and the present operators literally work in the dark and have ttle or nothing to guide them in working close to adjoining mines, if any re present, and have little knowledge of caved or abandoned sections of eir own mines or adjacent mines. Lack of inspection, poor supervision, nd lack of co-operation between the operating department and engineering partment also contribute to such accidents.

Some accidents of this kind occur in spite of taking the known ecessary precautions, but these are rare and, if a close study were be made of them, it probably would be found that one or more of the esirable precautions had not been taken.

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The following accidents emphasize the need for precaution when mine workings approach old, abandoned, or sealed regions and when connections are to be made in active workings.

DETAILS OF ACCIDENTS

The three following cases are examples in which no precautions were taken, although in each the need for taking precautions was indicated.

Bituminous Coal Mine, Pennsylvania

A local gas ignition between 9:00 and 9:30 p.m. severely burned a miner, who later died. Nine other men in the vicinity of the ignition escaped uninjured.

Two rooms, Nos. 21 and 22, had been driven at some previous date, and seals had been placed at the entrance to room 21 and diagonally across room 22, from the lower rib of the first crosscut to room 21 to the upper rib of the first crosscut to room 23, but no provision had been made to examine for gas or to collect samples of air from behind the seals. A blind crosscut had been driven in 30 feet on the left side of room 21 when it was advancing about 105 feet from the mouth of the room.

Room 20 had been cut the night before the accident, but it was not known whether it had cut through to the face of the crosscut from room 21. The miner drilled and fired a shot in the center of the cut soon after he arrived on the night of the accident. The night fireboss stated that he had examined the place about 6:30 p.m. and found no indications of gas and no evidence that the place was through to the crosscut.

The miners had loaded out three or four cars of coal from the cut before the fireboss examined the place. Sometime afterward a shell of coal 18 to 20 inches thick fell from the face and was loaded. About 9:00 p.m. the miners asked the machine runner to move the cutting machine from the room switch, and the ignition was caused by an arc when the cable nips contacted the trolley wire. The gas had traveled from the face of the room (about 105 feet) to the room entry, where it was ignited.

Remarks:

This is an instance where essentially no precautions were taken, despite the fact that maps indicated the crosscut, the condition of the air behind the sealed area was unknown, though the presence of methane should have been suspected. The accident was the result of violating the State mining laws, in that the operating officials did not instruct the miner

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to drill boreholes ahead of the face when approaching a section of the mine known to be unventilated.

Arkansas Coal Mine

Water breaking through the room face of a pillar separating a worked-out and flooded mine and an adjacent active mine drowned 4 men; the pillar was only 2 1/2 to 3 1/2 feet thick where the water broke through.

The active mine was opened with a 3-entry slope on a pitch of about 3°. Parallel entries are turned off both sides of the slope at intervals of approximately 350 feet.

The water broke through at the face of a room off an entry driven between the 1 and 2 east entries about 600 feet from the slopes. Two men were drowned in this entry and one each in the lower 2 and 3 east entries.

The room into which the water broke was driven 30 feet wide in coal 3 1/2 feet thick. The face had been cut and shot 5 days before the accident occurred, and the coal was being loaded out when the water broke through.

The investigation indicated that water was not suspected, though conditions were such that even ordinary prudence demanded taking precautions.

Remarks:

This accident indicates poor engineering and poor planning on the part of the mine management; the mine officials knew about the worked-out mine and should have procured maps of the workings adjacent to their mine. If these could not be obtained, or even if they were obtainable and were defective, pilot or drill holes should have been kept ahead of advancing workings, as conditions were known to be such that at least some of the workings of the adjacent abandoned mine were almost certain to be filled with water.

Metal Mine, Colorado

Four men were drowned and much property damage was caused when a round of shots from a stope broke into abandoned mine workings filled with water.

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The mine being worked had been idle for several years and, because inaccessible from the surface, was being operated through a drainage tunnel, the portal of which was 1,400 feet lower than the collar of the shaft of the old mine. The active workings of the mine were reached by traveling through the tunnel to a drift of the old mine and through raises to the working level.

The manager of the company believed that no water was present in the abandoned workings, notwithstanding the fact that considerable water had been found in the stope where the men had been working. The deputy State mine inspector stated he had ordered the miners not to blast if water was flowing from holes too rapidly, and to carry a pilot hole ahead. A former workman stated that dynamite would not stay in some of the drill holes unless wooden wedges were driven into the holes as soon as the loading stick was withdrawn. The source of the water was not definitely known, but it was believed that the last round in the stope broke through into old workings of the mine.

Remarks:

Little or no thought was given to the possibility that water would be found in working this mine, in spite of the fact that it was being worked below inaccessible workings of an old mine in a region in which water was definitely known to occur in the strata. The heavy flow of water from the drill holes should have been recognized as an indication of the proximity of water, and extra precautions should have been taken; but it is apparent that this was ignored, or at least not considered hazardous, and the blunder cost four lives and considerable property damage.

INACCURATE MAPS

The following are examples of accidents due to inaccurate maps or to failure to use maps as guides. In some of these cases, holes were drilled ahead, but poor supervision contributed largely to occurrence of accidents. In all of these examples, drill holes ahead, together with good supervision, would have supplied information which, if followed carefully, would in all probability have averted the accidents.

Pennsylvania Anthracite Mine

Three men were injured, two of whom died later, when the face of a chamber being driven to the outcrop broke into an old slope filled with water.

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Two chambers were being driven in the bottom vein to the outcrop in what appeared on the mine map to be solid coal. The map of the adjoining mine showed a slope had been driven 135 feet in another vein, but none in the bottom vein. As a result of encountering water several months previous to this accident, a drill or pilot hole was kept 20 feet ahead of the face, and holes were drilled to the right and left of the chamber after each 3-foot cut was taken out.

On the day of the accident, a 20-foot hole had been drilled in the face and both sides of the chamber. The water broke through on the left rib about 3 feet from the face and extended down the pitch 18 feet.

It was learned later that after the miners drilled pilot holes in the left rib and the place was inspected by a company official, they were in the habit of drilling holes in the left rib and shooting the coal down and, by slabbing the rib, procured "easy" coal. This had been done for 80 feet and had not been detected by the supervisors, as cribs were carried along the left side and the rib could not be seen.

An investigation of the accident revealed that a slope from the outcrop had been driven in the upper vein and extended 235 feet and was to the left of the advancing chamber.

Remarks:

Two factors entered into this accident - inaccurate maps and the reprehensible actions of the miners. The management suspected that old workings were being approached and took the essential precaution of drilling ahead, but the pillar had been weakened by the miners by surreptitious slabbing of the coal. Although this accident was due to the actions of the miners, poor supervision on the part of management also was responsible, as the supervisors or engineering staffs failed to detect the slabbing.

Anthracite Coal Mine, Pennsylvania

Two miners working in a slope heading had cleaned the place and fired three shots in the face. The third shot broke through to an apparently unmapped region of considerable extent and volume containing explosive gas, which came into the slope, and the men decided to go home but failed to warn the 11 other men working in the section. The two men had gone only about 500 feet up the slope when the gas was ignited, and a local explosion ensued. They were slightly burned and peppered with fine coal, but four of the other men were killed and two were burned and entombed behind some falls for 132 hours before being rescued.

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Remarks:

This is a case of poor engineering or inaccurate maps, or both; the slope was being driven into solid coal, as shown by the maps, and drilling ahead was not thought necessary. The explosion might have been averted had the workmen who broke through realized the hazard or had a company official been present. This accident occurred about 6 p.m., when there was little or no supervision at the mine.

Metal Mine, Utah

Fifteen men were overcome by air deficient in oxygen and high in carbon dioxide, which entered the active mine workings when a drift broke into an abandoned timbered stope.

A drift was being driven to intersect an abandoned timbered stope near the 1,700-foot level, which the mine map indicated to be about 60 feet from the face of the drift. A driller thought that his drill had entered the old stope the night before the accident, but the round was shot and the place was not inspected though the foreman was notified that a drill probably had entered the old stope. Several day-shift men went into the 1,700-foot level, but their carbide lamps were extinguished, so they immediately signaled to be hoisted to the surface. The 15 men who were overcome entered the workings from another direction. A company rescue crew wearing oxygen breathing apparatus brought 14 men to fresh air, where they were revived after artifical respiration was administered; but the fifteenth man, who was in the bad air for 4 hours, was dead when found.

Remarks:

This accident could have been prevented had these workings been inspected before the shift entered the mine. Furthermore, it is well known in the district where this accident occurred that abandoned timbered workings are likely to be deficient in oxygen, but no precautions were taken preparatory to the break-through. Again, this is an example of inaccurate maps, inasmuch as it was thought that the distance from the face of the drift to the old stope was at least 60 feet, and essentially no consideration was given to the effect the connection would have upon ventilation of the mine or removal of bad air, should it be encountered.

Coal Mine, Tennessee

Ten men were killed in an explosion in this mine when a mining machine cut into abandoned workings containing methane, which was ignited by an arc from the mining machine.

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An angle room was being driven off the face of an entry to connect with a room driven previously off an abandoned entry. The abandoned entry could not be inspected, and the condition of the air was unknown. According to the mine map, the rooms were a considerable distance apart, and no drill holes were kept in advance of the face or to the side. The mining machine made a semicircular cut, which cut into the old room, and explosive gas filled the active workings and was ignited by electric arcs from the nonpermissible mining machine.

Remarks:

Although this disaster was caused by a nonpermissible mining machine, a careful analysis of the disaster would class the ignition of the gas as a contributory cause, inasmuch as the primary cause was the breaking into the abandoned workings with release of gas. The fundamental cause of the accident was the lack of accurate mine maps and the failure to take necessary precautions when approaching known abandoned workings, the condition of which was unknown.

Bituminous Mine, Pennsylvania

Two machine men were suffocated by vitiated air released under pressure when their mining machine cut into an abandoned part of the mine. The nearness to old workings was suspected, and the following day a pilot hole was to have been drilled ahead of the face, but instead of 11 or 12 feet of coal, as indicated by the survey, the actual distance was much less.

Remarks:

This is a case of placing too much faith in a mine map. Even the best of mine maps can be wrong, and in this instance waiting until only 11 or 12 feet from abandoned workings before drilling holes in advance leaves essentially no margin of safety. This accident would not have occurred if the state mining law had been followed by advancing drill holes 20 feet ahead of the face. This is a good example as to the necessity of having laws stating that drill holes should start a certain number of feet from known or suspected abandoned and sealed workings.

Coal Mine - West Virginia

Fortunately, no accidents resulted from the following instance where the face of an active room shot through into old workings releasing gas but it illustrates the hazards that can be caused by inaccurate maps.

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A Federal mine inspector in checking over the fire boss' report book before entering the mine noted that gas was reported in one of the working places where gas had never been reported before and was coming from old workings. A shot the previous evening in the face of a room had blown through into the face of a dead end crosscut, which was not indicated on the map. The inspector accompanied the mine foreman into the mine on the man-trip and went to the place reported and an explosive mixture of gas was found. The men in this section were sent home and the gas removed by erecting a line brattice and increasing the air current.

The foreman stated that the room was expected to break into a parallel entry which was well ventilated, and according to measurements on the mine map the room would have to be driven 218 feet from the one entry before breaking into the other entry. The room was driven 160 feet when a shot in the face blew through into the face of a dead end crosscut and old workings which were not shown on the map.

Remarks:

This is another instance, of several reported recently, where maps were inaccurate or where for some reason some workings were not shown. A serious accident, possibly a gas and dust explosion, could have resulted if a mining machine had cut through this place releasing the gas into the active workings while the mine was working. The officials of this mine had no indications that old workings were close, hence no precautions were thought to be necessary. This case illustrates the necessity of care and accuracy in the making of surveys and extending workings on mine maps. Mine disasters can and do occur because of inaccurate mapping and the mine engineer has a very definite responsibility in doing his particular part in trying to prevent accidents in and around mines.

APPROACHING ACTIVE WORKINGS

Failure to know the nearness of active workings is well illustrated in the following cases, which illustrate the need of knowledge by supervisors and mine officials of the distance separating places being driven towards each other so that precautions can be taken in placing shot holes.

Coal Mine, Kentucky

A shot breaking into an adjoining room from a crosscut initiated a coal-dust explosion in a Kentucky mine. The explosion involved all of the active workings of the mine and resulted in the death of 23 men, only 14 men escaping unassisted.

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Several shots had been drilled on the solid in a crosscut being driven
an adjoining room; they were charged with black powder and stemmed
th coal dust. The first shot evidently had been drilled to within 14 inches
the rib of the adjoining room and broke through and threw considerable
st into suspension both from the coal it broke and the coal cuttings in the
r, and in addition it may have exposed the explosive in the other hole.
hen the second shot was fired, it expended its force largely, if not wholly,
to the air and ignited the dust raised by the previous shot.

marks:

In spite of unsafe mining practices and poor blasting procedures, this
losion resulted from not knowing the proximity of adjoining workings or,
known, ignoring them or possibly not realizing the danger that exists in
ch situations.

Coal Mine, Colorado

A dust explosion in a Colorado coal mine killed the shotfirer and
ecked the mine when a shot blew through a crosscut into an adjoining
om, igniting the coal dust.

A badly placed shot in room 3 partly blew out, causing coal dust to
e thrown into suspension. The next shot fired into a crosscut from room
to room 3 (this crosscut was almost through) "squealed" through crevices
to room 3 igniting the dust in suspension from the previously mentioned
rtly blown out shot in room 3. The tamping was still intact in the drill
le in the crosscut, and no coal was broken.

marks:

This explosion resulted from not knowing how close one part of a
ine was to connecting with another, and although it was only a room
osscut, it shows that any mine connection may have conditions or may
use the formation of conditions that are potentially hazardous. In this
stance, poor blasting practices and the use of black powder were the
mediate causes of the explosion, but it would not have occurred if the
seness of the workings had been known and if proper precautions had
en taken.

ACCURATE MAPS AVAILABLE

Although accurate maps were available in the following examples
accidents due to breaking into adjacent workings, other factors entered

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into the accidents. Poor supervision and lack of accurate checks on the advancement of the working places by the engineering departments were largely responsible for these accidents. Accurate maps alone will not prevent such accidents; suitable action must be taken to utilize the information obtainable from maps.

Anthracite Mine, Pennsylvania

A chamber was being driven to the dip off an upper gangway to connect with the face of a chamber previously driven up the pitch from a lower gangway for the purpose of improving the ventilation in the upper gangway. The new chamber "holed" through to the face of the old chamber, releasing a large volume of methane, which came through the hole and filled the new chamber and upper gangways with explosive gas. The gas was ignited by a direct current-driven scraper-hoist motor on the gangway, and an explosion ensued that killed one man and slightly burned three others.

The chamber to which the connection was to be made was in a section that had not been worked for two years and that had not been thoroughly inspected for gas prior to the break-through. The miner had been told to drill hole in advance of the face of the chamber, and a 9-foot hole is said to have been drilled, but it did not go through (the State law requires 20-foot holes). Later, an investigation at the face of the old chamber failed to show any evidence of a pilot hole; however, it was stated that the miner charged and fired the pilot hole which broke through to the old chamber. This hole was only about the size of a fist and the pillar between the two chambers was about 15 inches. The gas from the old chamber and section escaped through the hole and filled the new chamber and upper gangways. The hole was through several hours before the explosion occurred but the mine officials were not notified of this and tests were not made for gas.

Remarks:

In this instance, it was known that the chambers were about to be connected, as there were accurate maps from which to measure; but the mine officials and miners failed to take the necessary precautions and, through negligence or poor supervision, or both, did not realize the possible danger that might be encountered upon breaking into abandoned workings. Although this accident is the direct result of carelessness and negligence on the part of the mine officials, the workers also were at fault in not reporting that the hole had penetrated into the adjacent workings.

Coal Mine, Alabama

Two men of a motor crew were severely burned when a spark from the trolley wheel ignited a pocket of gas in a roof cavity in a gassy Alabama coal mine.

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A new airway parallel to the haulage entry, which was on return air, had been driven from the inby end to intersect the main return air courses for this section and as the crosscuts were completed permanent stoppings were erected. The airway had broken through into the main return 2 days previous to the accident, but the coal was not cleaned out and the break-through completely opened until a few hours before the ignition of the gas. The cleaning up of the cut short-circuited the air from the haulage entry, with the result that gas accumulated in roof cavities and was ignited by a spark from the trolley wheel of the locomotive.

Remarks:

Although this accident was the result of a combination of conditions, such as poor supervision, lack of ventilation, and haulageways on return air, the primary cause of the accident was the intersection of the new airway with the main return. No precautions were taken or thought given to the effect connection of the airways would have on the ventilation. In this instance, the break-through did not result in the release of explosive gas, but it caused the air to be short-circuited from another entry, allowing the gas to accumulate. It is obvious that the ignition might not have occurred if precautions had been taken prior to connecting the two entries. This illustrates the need of taking extra precautions when connections are made either to abandoned worked out sections or known working sections of a mine.

Coal Mine, West Virginia

An explosion that took the lives of 11 men in this West Virginia mine was caused by entrance of gas into the active workings when a mining machine cut through into an abandoned section of the mine that was full of explosive gas.

Five rooms were being driven off an entry towards the aircourse of a parallel entry, which had been idle and abandoned for about 8 years. The abandoned entry could not be inspected, and it was thought that it might contain water and gas. The room that broke through was the center room and was used as the haulageway for the set of 5 rooms. The mining machine cut through the pillar while sumping and continued to cut the full width of the face (30 feet) in the early part of the shift (the afternoon or evening shift). The gas was ignited about 330 feet from the face of the room or the break-through by an arc from the locomotive cable nip, when it was removed from the trolley wire.

The safety lamp of the section foreman was extinguished soon after the machine broke through and could not be relighted. The foreman sent the lamp outside by the motor crew and requested that another lamp be sent to him.

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After the explosion, it was learned that a 12 1/2-foot pillar was supposed to have been left between the face of the 5 rooms and the rib of the entry. It had been planned to drive one of the end rooms narrow and break through into the other entry to dewater the abandoned section. However, in spite of accurate maps, which showed the exact distances, the mine foreman or the assistant mine foreman apparently had no definite instructions as to what rooms to drive, and no checks or measurements were made as to the distance the rooms should advance and then be stopped.

Remarks:

This disaster occurred in a mine that has far better than average safety practices. It was highly mechanized and followed sound engineering and mining practices; however, as can be seen, little or no precaution had been taken when it was known that an abandoned, unventilated section that could not be inspected was being approached. This disaster was the result of lack of instructions to the operating force and the failure of accurate and frequent check of distances by the engineers. Lack of supervision also contributed to the disaster, as the section foreman failed to realize the hazard after the machine cut through; if boreholes had been drilled in advance of the face, the room could have been stopped before the machine cut through.

PRECAUTIONS TAKEN

The following case is unique, as supposedly all precautions had been taken to prevent the type of accident that occurred.

Metal Mine, Mexico

In a Mexican metal mine, 8 underground workers were drowned from a sudden inrush of water. The mine was ordinarily dry, and no signs of water were seen, when suddenly a large mass of water, rock, and mud broke into the mine on the 150-meter level, where four men were working. In a few minutes the lower levels were filled, and although three of the men below the 220-meter level were able to escape, five others were trapped. During recovery operations, it was found that the water came from some previously unknown workings, and that a plug of rock 6 meters long, 2 meters thick, and 4 meters high had broken loose, allowing the water to come through. No blasting had been done for several hours before the inrush, and although the accumulated water evidently was but 4 meters above the 150-meter level, it was said that there were no signs of the proximity of water on the 150-meter level.

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It was known that some old workings might be encountered, and the following precautions were taken; First, an escape raise had been driven to allow the men to climb and remain above water until rescued in case the water should break through; second, a guide hole had been drilled in every round for the purpose of prospecting ahead for water; third, no blasting was done until all men were out of the lower workings; fourth, extra long fuse was used to permit the men to arrive at a higher level before the shots fired; fifth, all miners were repeatedly requested to report at once any noticed seepage of water however small.

Remarks:

All the precautions thought necessary were taken to prevent this disaster, yet the water broke through. This example illustrates the hazards of impounded water and indicates that danger exists even when the best of precautions are taken; it appears that the drill holes were less than 4 meters (about 13 feet), and it is now known that they were not deep enough. This is a good argument in favor of having a 20-foot minimum depth of drill holes, as advocated by the Bureau of Mines, especially when old workings are suspected.

Accident Averted by Taking Precautions - Coal Mine

A safety-minded, progressive, coal company, knowing that an abandoned mine was adjacent to its property, planned to leave a 50-foot barrier pillar between its workings and the property line. A test hole was drilled in the face of an entry being driven toward the barrier pillar when it was thought that the entry had but 10 more feet to advance before reaching the barrier line, which was 50 feet from the property line. The test hole broke into water when it was drilled 10 feet, and at the point it broke through a 28-foot head of water was encountered. The hole was immediately plugged and a dam was erected of cement blocks across the entry; a second dam, constructed of brick 17 inches thick, was erected outside the first dam. Pipes were placed in the dam so the water could be pumped out.

Remarks:

The precautions taken by the operating company in drilling ahead when approaching old workings probably averted a serious disaster. The drill hole encountered water at 10 feet where there was believed to be 60 feet of solid coal; this indicates that the workings of the abandoned mine were approximately 50 feet beyond the boundry line and the maps of the active company would ordinarily not have the information to show this coal as having been removed.

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The test hole in breaking through at 10 feet performed its expected function and acted as a warning that enabled the operating company to alter its plans of mining so as to try to keep a barrier pillar of 50 feet or more between its workings and those of the abandoned mine.

Instances of this type are becoming more and more prevalent as mining properties approach property lines, and regardless of maps or supposedly known distances test holes should be carried ahead of the face when mine workings are thought to be within 200 feet of the boundary.

Lessons Taught by these Accidents

The above examples are representative of scores of accidents that occurred in relatively recent years and that continue to occur far too frequently in mining. The comments under "Remarks" following each instance briefly give the cause and the precautions that might have averted the accident. Although it may readily be seen that different conditions and circumstances were present in each instance, nevertheless, there was a marked similarity in the causes. Some of the remarks apply to all the accidents, some to the same group, and some to the particular one; but it is believed that definite lessons may be learned from each of these and that most of these accidents can be prevented, especially if the necessary precautions to be taken are pointed out.

Some of the lessons taught may be summarized as follows:

As many of these accidents resulted from using inaccurate maps or working without maps, it is obvious that every mine, regardless of size or type, should have available an accurate map which, in addition to showing all active workings should show all connections with other mines and workings, all abandoned, worked-out, sealed, and fire areas, if any, and all dammed or standing water areas. The map should show the boundaries of the workings of mines adjoining the property and the size of the boundary pillar. A copy of the mine map should be deposited with some State authority or agency when the mine is closed down, abandoned, or worked out, so that it would be available for reference to anyone again working the property or an adjoining property; this is decidedly desirable, inasmuch as in changing operators of a mine the maps are very likely to be lost. This is especially true if a mine has been idle for some years.

When it is known that workings will approach old or abandoned workings, an accurate survey should be made of the approaching working place with reference to the old workings, if it is at all feasible so that the real distances may be fairly well established. If this cannot be done, utmost

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precautions should be taken in drilling and blasting in the region of suspected or known abandoned workings.

Regardless of the supposed accuracy of the maps, drill holes at least 20 feet deep should be drilled ahead of the face when working places are known or suspected of being close to abandoned, sealed, or old workings the condition of which is unknown. Drill holes should be also drilled at least 25 feet deep on an angle of 45° to 60° in each rib at least every 8 feet. The working place should be driven at a minimum width. In coal mines, extra precautions should be taken on account of encountering sudden outbursts of gas, and only permissible mining equipment and explosives and lights should be used in the approaching workings.

Accurate and frequent check should be maintained of the distances in workings approaching abandoned or worked-out areas. This should be made in addition to the drill holes advanced ahead of the face.

Definite instructions should be issued to the operating mine officials (mine foreman, assistant foreman, section foreman), and the miners limiting the distance of the places to be driven, regardless of whether or not the areas being approached can be inspected.

A mine official should be at hand when a place is known to be close or about to break through.

Thought and consideration should be given beforehand to any place that is to connect active sections of a mine as well as to inactive or abandoned mines or parts of a mine as to the effect it might have on interrupting ventilation. In the past, numerous explosions have occurred as the result of short-circuiting air from a part of a mine because of a newly made break-through, with consequent ignition of gas by open lights, electricity, etc.

Care should be practiced when drilling boreholes and charging shots in places that are about to be connected in active workings. This is especially important when blasting is done while the working shift is in the mine, inasmuch as the newly made connection may short-circuit air through abandoned gas-filled workings and force accumulated gas into working places, to be ignited by open lights, smoking, electric arcs, etc.

Should water be encountered in shot drill holes in a place not known to be near old workings as shown on the map, it may indicate the proximity of a body of water, and pilot holes should be carried ahead of the face, and extra precautions should be taken. This is especially true if the strata are generally dry, and the wet condition appears unexpectedly.

0310

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The adoptions of precautions such as these, together with more thought and foresight of the hazards likely to be encountered when mine workings approach or are known to be near old, abandoned, or sealed workings, should greatly aid in reducing this type of accident, which are more and more likely to occur as mines become old and are abandoned and other mines are open or reopened in the same region.

The following tabulation gives the gist of requirements of some States in connection with the use of drill holes in trying to avoid accident when approaching old workings.

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State Laws Governing the Approaching of Old Workings

State	*Start when known, ft.	Drilling distance unknown, ft.	Length of drill hole, ft.	Length of lateral holes, ft.	Distance apart of lateral holes, ft.	Width of entry, ft.
Alabama	100	100	9	15 at 45°	6	8
Arizona	-	-	20	If needed	-	6
Arkansas	-	-	20	-	-	-
California	-	-	18	-	-	-
Colorado	-	-	12 (2 holes)	12	8	8
Iowa	-	-	-	-	-	-
Indiana	-	-	9	-	-	8
Illinois	50	100	10	-	-	20
Kansas	-	-	12	-	-	-
Kentucky	50	100	12	-	-	-
Maryland	-	-	12	-	-	-
Missouri	-	-	20	-	-	-
Montana	100	200	12	-	-	-
New Mexico	100	-	18	When within 50 ft., 18 ft. deep	9	9
New York	-	-	15	-	-	6 x 8
North Dakota	100	200	12	-	-	-
Oklahoma	200	-	18	-	-	-
Ohio	100	150	Twice length of cutter bar	-	-	-
Pennsylvania (Bituminous)	-	-	20	-	8	-
Pennsylvania (Anthracite)	-	-	20	-	-	12
South Dakota	-	-	-	-	-	-

*Some States consider an accurate survey of the workings as "known distance." If an accurate survey is not made, the distance is considered "unknown."

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State Laws Governing the Approaching of Old Workings - (Cont'd.)

State	*Start when known, ft.	Drilling distance unknown, ft.	Length of drill hole, ft.	Length of lateral holes, ft.	Distance apart of lateral holes, ft.	Width of entry, ft.
Tenessee**						
Utah	100	-	15	-	-	6 x 8
Virginia	-	-	16	When necessary	-	-
Washington	-	-	20	12	-	8
West Virginia	-	-	12	When necessary	-	-
Wisconsin	-	-	18	-	-	-
Wyoming	-	-	12	-	-	-

*Some States consider an accurate survey of the workings as "known distance." If an accurate survey is not made, the distance is considered "unknown."
**Report to Mine Inspection when close.

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